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WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

GEORGIA PACIFIC, BELLINGHAM
CLASS II INSPECTION

by
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INTRODUCTION

Ecology conducted a Class II inspection at the Georgia Pacific pulp mill in Bellingham on August 8 - 10, 1988. Carlos Ruiz and Don Reif from the Ecology Compliance Monitoring Section conducted the inspection. Don Kjosness from the Ecology Industrial Section and Marc Heffner and Pat Hallinan from the Compliance Monitoring Section also attended during the inspection. Ed Dalgren, Environmental Supervisor for the mill, provided assistance.

The mill uses the sulfite process to produce bleached pulp and paper products. Wastewater generated at the mill is treated by primary clarification followed by biological treatment in an aerated lagoon. Treated effluent discharges (outfall 009) to outer Bellingham Bay as regulated by National Pollutant Discharge Elimination System (NPDES) Permit No. WA 000109-1. Chlorine used by the mill in bleaching operations is produced on site by a mercury cell chlor-alkali plant. Wastewater from the chlor-alkali plant (specifically the mercury recovery unit) is also regulated under the NPDES permit.

A year prior to the inspection, mercury contaminated wastewater from the mill discharged through a non-permitted outfall to Whatcom Waterway (through the old chlor-alkali plant outfall line). According to mill personnel, the discharge lasted only one day (Kjosness, 1988). Georgia Pacific subsequently sealed the outfall line. However, no assessment of sediment contamination was made at that time. Whatcom Waterway and Bellingham Bay have been previously contaminated by mercury from the chlor-alkali plant during 1965 to 1970 when up to 19 pounds of mercury was discharged per day (Crecelius *et al.*, 1975).

Objectives of this inspection included:

1. Verify compliance with NPDES permit limits.

2. Characterize the influent to the aerated lagoon, effluent, centrifuged effluent particulates, and sediments surrounding the outfall for toxic pollutants.

3. Characterize treated effluent for toxicity using rainbow trout, *Daphnia pulex*, echinoderm (*Dendraster excentricus*), and fathead minnow (*Pimephales promelas*) bioassays and the Ames test. Sediment toxicity will be tested using *Rhepoxynius abronius*.

4. Assess the sediment mercury contamination surrounding the non-permitted discharge (at the old chlor-alkali plant outfall).

5. Verify the permittee's self-monitoring by reviewing laboratory, sampling, and flow measurement procedures. Samples were split with the permittee to determine the accuracy of laboratory results.

PROCEDURES

Ecology collected 24-hour composite samples of influent to the aerated lagoon (referred to as the influent sample) and treated effluent (see Figure 1). Two composite samplers were used at each station; one collected samples for conventional analyses while the other collected priority pollutant samples. The samplers collected about 330 mLs of wastewater every 30 minutes for 24 hours.

Composite samplers used to collect priority pollutant samples were fitted with glass sampling bottles and teflon tubing. This equipment was cleaned prior to use by washing with non-phosphate detergent; then rinsing successively with tap water, 10 percent nitric acid, three times with de-ionized

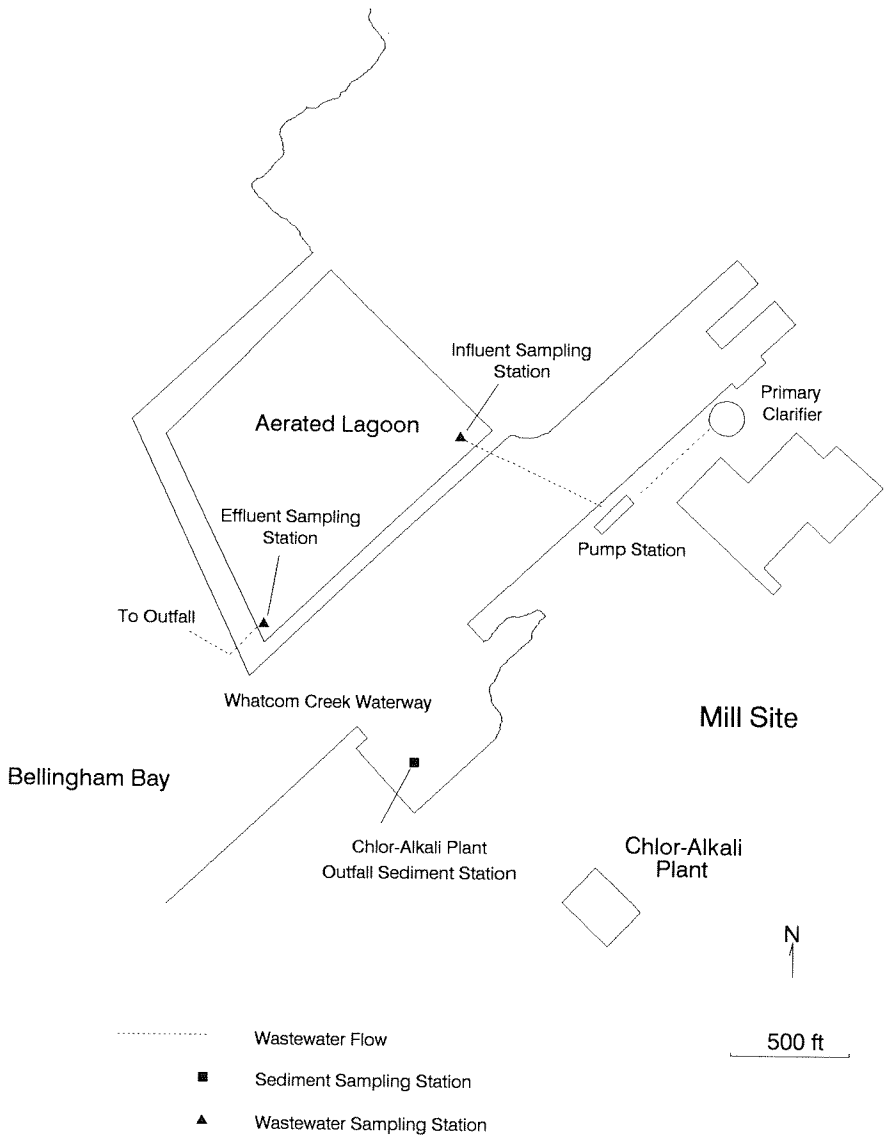

Figure 1 - Mill Site Location - Georgia Pacific, 8/88.

water, pesticide-grade methylene chloride, and finally with pesticide-grade acetone. Collection equipment was air-dried, then wrapped in aluminum foil until used in the field.

Ecology also collected 24-hour composite samples at two locations in the effluent of the mercury recovery unit (MRU). One sampling point was upstream of a filter located ahead of a continuous mercury monitor that monitors wastewater from the MRU. The other sampling point was located downstream of this filter. Additionally, Ecology collected grab samples for field and laboratory analysis of influent to the aerated lagoon, treated effluent, and wastewater from a clear water sump. The clear water sump receives wastewater from the MRU and non-contact cooling water. Sampling times and parameters analyzed are listed in Table 1.

Three sites were sampled for bottom sediments in the vicinity of the wastewater outfall (Figure 2): at the outfall, at the edge of the NPDES permitted dilution zone (below outfall), and at a spot approximately 1-1/4 mile from the outfall (field control). In addition, sediment was collected at the old chlor-alkali plant outfall (Figure 1). Bottom sediments were collected using a 0.1-square-meter van Veen sampler following recommended Puget Sound Protocols (Tetra Tech, 1986).

Samples consisted of three to four grabs in which the top two centimeters from each grab were collected, then composited. Composites were thoroughly mixed and divided for separate analyses (except for samples for volatile organic analyses which were taken directly from the van Veen). Utensils used in the sediment collection were stainless steel and were cleaned by the same procedures as the wastewater composite samplers.

Effluent particulate matter was collected by a Alfa Laval bowl-type continuous centrifuge. The centrifuge (gyrotester model) was rated for maximum flow of 2 L/min with a bowl spin rate of 7000 rpm. Effluent was fed to the centrifuge using a variable-speed peristaltic pump with teflon tubing. The centrifuge internal parts were constructed of stainless steel. These parts, as well as the teflon tubing used in pumping, were cleaned before use with the same procedures as the effluent and sediment collection equipment.

Samples collected during the inspection were analyzed for general chemistry parameters by the Ecology Manchester Laboratory. Laucks Testing Labs of Seattle performed the volatile, semi-volatile, pesticide/PCB, and resin acid/guaiacol analyses. The Ecology laboratory also performed the sediment amphipod bioassay (*Rhepoxynius abronius*), and the effluent 48-hour acute *Daphnia pulex*, 96-hour rainbow trout (*Oncorhynchus mykiss*), and echinoderm (*Dendraster excentricis*) sperm fertilization bioassays. EA Engineering, Science, and Technology, Inc. of Lafayette, California, completed the 48-hour acute fathead minnow (*Pimephales promelas*) bioassay, while the Ames test was performed by SRI International of Menlo Park, California. Appendix 1 lists the chemical and bioassay test methods used.

The semi-volatile analyses of both the water and sediment samples failed to meet certain Environmental Protection Agency (EPA) contract lab program (CLP) holding time requirements. For the water samples, the holding time from collection to extraction exceeded the EPA CLP limit by one day. This is viewed as minor, and the resulting data are considered acceptable. The sediment samples met the extraction holding time from the date of collection. However, the extract was held for 65 days beyond the 40-day holding time before analyses were started. Therefore, the values for the semi-volatile compounds detected should be treated as estimates. These values are thus flagged by an "E" in this report.

Table 1. Sampling Times and Parameters Analyzed - Georgia Pacific, 8/88.

Station:	Influent		Effluent			Centrifuged Effluent Solids	Clear Water	MRU Pre-filter	MRU Post-filter	Sediments			
										Field Control	At Out-fall	Near Out-fall	Chlor-ine Plant Out-fall
Type:	Grab	Composite	Grab		Composite	Composite	Grab	Composite	Composite	Grab	Grab	Grab	Grab
Date:	8/23	8/23-24	8/23	8/23	8/23-24	8/23-24	8/23	8/23-24	8/23-24	4/18	4/18	4/18	4/18
Time:	1600	0900-0900	1053	1600	0910-0910	0910-0910	1600	1035-1035	1035-1035	1720	1800	1840	1840
Laboratory ID#:	358185	358189	358186	358187	358190	358194	358188	358193	358192	358180	358181	358182	358183
GENERAL CHEMISTRY													
Turbidity (NTU)		X			X			X	X				
pH (S.U.)		X	X	X	X								
Cond. (umhos/cm)	X	X	X	X	X			X	X				
Alk. (mg/L as $CaCO_3$)		X	X	X	X								
Hard. (mg/L as $CaCO_3$)		X			X								
Cyanide (mg/L)		X			X	X				X	X	X	X
Solids (mg/L)													
TS		X			X								
TNVS		X			X								
TSS		X	X	X	X								
TNVSS		X			X	X							
BOD_5 (mg/L)		X			X								
COD (mg/L)	X	X	X	X	X		X	X	X				
Nutrients (mg/L)													
NH_3-N		X	X	X	X								
NO_3+NO_2-N		X	X	X	X								
T-Phosphate		X	X	X	X								
F.C. (#/100 mL)			X	X									
% Kleb				X									
% Solids						X				X	X	X	X
Grain Size						X				X	X	X	X
Oil/Grease (mg/L)			X	X									
ORGANICS + METALS													
pp Metals		X			X	X				X	X	X	X
Mercury				X			X	X	X				
Semi-Volatiles		X			X	X				X	X	X	X
Volatiles	X		X			X				X	X	X	X
Pesticides/PCBs		X			X	X				X	X	X	X
Resin Acids & Guaiacols		X			X	X				X	X	X	X
Phenols (ug/L)		X			X	X				X	X	X	X
TOC (mg/L)					X	X				X	X	X	X
TOX (mg/L)		X			X								
BIOASSAYS													
Trout					X								
Daphnia pulex					X								
Fathead Minnow					X								
Echinoderm					X								
Rhep. Abr.										X	X	X	X
Ames Test					X								
FIELD ANALYSES													
Temperature (°C)	X	X	X	X	X		X	X	X				
pH (S.U.)	X	X	X	X	X		X	X	X				
Cond. (umhos/cm)	X	X	X	X	X		X	X	X				

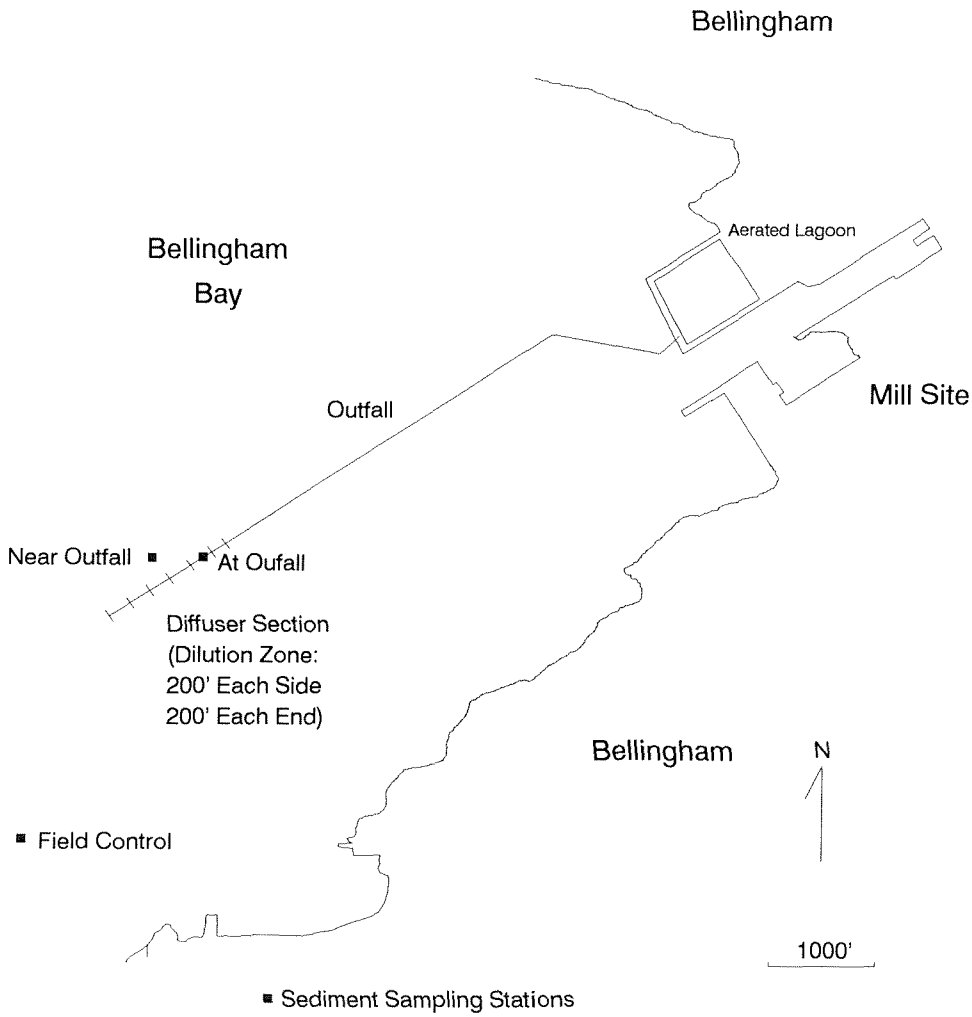

Figure 2 - Outfall Sediment Sampling Stations - Georgia Pacific, 8/88.

RESULTS AND DISCUSSION

Comparison of Effluent Parameters to NPDES Permit Limits

Conventional data collected during the inspection are summarized in Table 2. A comparison of effluent parameters to NPDES permit limits is given in Table 3. Biochemical oxygen demand (BOD), total suspended solids (TSS), and pH at outfall 009 were well below the daily average and daily maximum permit limits. The effluent also passed the rainbow trout bioassay with a 100 percent survival in 65 percent effluent (Table 4).

Effluent from the MRU was below the permit requirement for total mercury. However, mercury was detected above the daily maximum permit limit (0.11 pounds per day) in the influent and effluent composite samples (0.29 and 0.13 pounds per day, respectively) and in a clear water grab sample (1.48 pounds per day). Mercury in the clear water grab sample exceeded the concentration in the MRU effluent, suggesting another source of mercury to the clear water sump. Past Ecology samplings have shown clear water sump mercury concentrations far below MRU effluent mercury concentrations (Kjosness, personal communication). The source of the mercury in these wastewater streams should be identified. Permit limits for total mercury should also be included in the next permit for the influent, effluent, and clear water wastewater streams as well as the MRU effluent.

Effluent Bioassay Results

Effluent bioassay results are presented in Table 4. As mentioned above, no mortality occurred in the rainbow trout bioassay. No mortalities also did not occur in the 48-hour acute fathead minnow bioassay at effluent concentrations ranging from 100 to 1 percent. In the 48-hour acute *Daphnia pulex* test, mortality in a 100 percent effluent concentration was not significantly different than in the laboratory control. Additionally, the effluent showed no mutagenic response in the Ames test.

Although the effluent showed no acute toxicity in the three acute bioassay tests performed, significant chronic effects were observed in the echinoderm sperm fertilization test. An effluent concentration of 0.62 percent resulted in a 50 percent reduction in fertilization rates compared to the laboratory control (e.g., EC_{50} = 0.62 percent). The Pacific oyster embryo development bioassay used at prior Ecology biomonitoring inspections at both bleached sulfite and Kraft mills yields similar results with EC_{50}s ranging from 0.2 to 0.5 percent. Both of these tests should be used for the chronic bioassay requirement in the next issuance of the NPDES permit.

Effluent Chemistry

Organic compounds detected in the influent, effluent and centrifuged effluent solids are listed in Table 5. Complete results are given in Appendix 1. Acetone and methylene chloride, common laboratory contaminates, were detected in the effluent and field transfer blanks. Relatively few organics were detected in the effluent compared to the influent and centrifuged effluent solids. Compounds found in the effluent sample included chloroform at 42 ppb (parts per billion or ug/L), 3,4,5-trichloroguaiacol at 5 ppb, and tetrachloroguaiacol at 7 ppb.

In the pesticide/PCB scan, delta-BHC was detected in the influent and effluent at 0.2 and 0.5 ppb, respectively. Technical grade BHC consists of five isomers of which the delta isomer comprises about three to four percent of the total. The gamma isomer (lindane) has virtually all of the insecticidal activity; since 1978, only it has been used as an insecticide (EPA, 1980). Since lindane or no other BHC isomers were detected in either the influent or effluent samples, the delta-BHC result may be suspected.

Table 2. Ecology Analytical Results - Georgia Pacific, 8/88.

Station:	Influent		Effluent			Clear Water	MRU Pre-filter	MRU Post-filter
Type:	Grab	Composite	Grab		Composite	Grab	Composite	Composite
Date:	8/23	8/23-24	8/23	8/23	8/23-24	8/23	8/23-24	8/23-24
Time:	1600	0900-0900	1053	1600	0910-0910	1600	1035-1035	1035-1035
Parameters Laboratory ID #:	358185	358189	358186	358187	358190	358188	358193	358192
GENERAL CHEMISTRY								
Turb. (NTU)		30			25		8	13
pH (S.U.)		6.0	6.4	6.5	6.8			
Cond. (umhos/cm)	2,050	2,150	2,100	2,210	2,160		40,000	40,300
Alk. (mg/L as $CaCO_3$)		177	78	76	75			
Hard. (mg/L as $CaCO_3$)		740			640			
Cyanide (mg/L)		<0.005			0.010			
Solids (mg/L)								
TS		2,900			2,200			
TNVS		1,500			1,500			
TSS		190	66	45	80			
TNVSS		120			48			
BOD_5 (mg/L)		390			20			
COD (mg/L)	1,500	1,700	880	860	910	24	450+	270+
Nutrients (mg/L)								
NH_3-N		7.7	8.0	8.4	7.4			
NO_3+NO_2-N		0.07*	0.04*	0.04*	0.04*			
T-Phosphate		4.3	2.0	2.1	2.1			
F.C. (#/100 mL)			220**	310**				
% Kleb				91				
Oil/Grease (mg/L)			<1	<1				
ORGANICS + METALS								
Mercury (ug/L)				0.40		23.01	4.81	5.65
Phenols (ug/L)		80			6			
TOC (mg/L)					311			
TOX (mg/L)		NAI			NAI			
FIELD ANALYSES								
Temp. (°C)	31.0	7.5	28.0	29.4	5.5	29.8	7.7	7.6
pH (S.U.)	6.78	6.29	6.68	6.64	6.79	6.67	3.24	3.27
Cond. (umhos/cm)	2,000	2,000	1,920	2,300	1,940	2,500	45,100	44,800

* - Result low due to an interfering substance
** - Many background organisms
\+ - Interfering substance
NAI - No analytical result due to an interfering substance.

Table 3. NPDES Permit Limits Compared to Inspection Data - Georgia Pacific, 8/88.

Parameter	NPDES Permit Limits		Inspection Data				
	Daily Average	Daily Maximum	Ecology Composite (009)	Georgia Pacific Composite (009)	Clear Water Sample	Mercury Recovery Unit	Grab Samples (009)
BOD_5							
(mg/L)			20	15			
(lbs/D)	21,500	41,300	6,572	4,929			
TSS							
(mg/L)			80	76			
(lbs/D)	33,600	62,600	26,288	24,973			
pH (S.U.)	5.0 - 9.0						6.7;6.6
Total Mercury*							
(ug/L)			0.39	0.33	23.0	5.65	
(lbs/D)	0.05	0.11	0.13	0.11	1.48	0.01	
Bioassay	80% survival in 65% effluent		100 %	100 %			
Flow (MGD)			39.40	39.40	7.70	0.177	

* - Applies to mercury recovery unit effluent only.

Table 4. Effluent Bioassay Results - Georgia Pacific, Bellingham, 8/88.

48-hour Daphnia pulex:

% Effluent	% Survival
Control	80
100	95

Echinoderm Sperm Fertilization:

% Effluent	% Unfertilized Eggs*
Control	5.7
0.8	62
1.6	72
3.2	92
6.3	95
12.5	100
25	100
50	100

EC50 (95% C.L.) = 0.62% effluent (EFF-ECO)

96-hour Rainbow Trout:

% Effluent	% Survival
Control	100
65% Effluent	100

Fathead Minnow Bioassay:

% Effluent	% Survival
Control	100
1	100
10	100
25	100
50	100
100	100

Ames Test: No mutagenic response.

* - Adjusted mean, transformed with Abott's correction (Dinnel and Stober, 1987).

Table 5. Organic compounds detected in water samples - Georgia Pacific, 8/88.

Compound	Influent (ug/L)	Effluent (ug/L)	Centrifuged Effluent Solids (ug/kg dry)
Volatile Organics:			
Chloroform	890	42	1,900
2-Butanone	15 U	3 U	27,000
Toluene	5 U	1 U	320
Phenols:			
Phenol	4 BT	2 U	13,000 U
4-Methylphenol	2	2 U	26,000 E
2,4-Dichlorophenol	4	4 U	26,000 U
2,4,6-Trichlorophenol	23	4 U	26,000 U
Polyaromatic Hydrocarbons (PAHs):			
Naphthalene	24	4 U	32,000 E
Acenaphthylene	11	2 U	16,000 E
Phenanthrene	11	2 U	48,000 E
Fluoranthene	5	2 U	40,000 E
Pyrene	5	2 U	37,000 E
Miscellaneous:			
Dibenzofuran	4	2 U	13,000 U
Resin Acids/Guaiacols:			
Isopimeric Acid	10	6 U	960 U
Palustric Acid	3 U	6 U	960 J
Abietic Acid	18	6 U	1,600
Dehydroabietic Acid	93	6 U	2,500
14-Chlorodehydroabietic Acid	120	6 U	3,000
12-Chlorodehydroabietic Acid	230	6 U	15,000
Dichlorodehydroabietic Acid	59	6 U	13,000
Guaiacol	94	2 U	1,400
4,5-Dichloroguaiacol	2	2 U	320
3,4,5-Trichloroguaiacol	7	5	3,400
4,5,6-Trichloroguaiacol	4	2 U	1,400
Tetrachloroguaiacol	8	7	5,100
Pesticides:			
Delta-BHC	0.20	0.50	8 U

Qualifiers:
U - Not detected at detection limit shown.
E - Estimated amount, EPA CLP holding time from extraction to analyses was exceeded.
J - Estimated amount, concentration is below method detection limit.
BT - Also detected in field transfer blank.

Other organics detected in the influent sample included chloroform at 890 ppb, 4-methylphenol at 2 ppb, 2,4-dichlorophenol at 4 ppb, 2,4,6-trichlorophenol at 23 ppb, dibenzofuran at 4 ppb, numerous polyaromatic hydrocarbons (PAHs) up to 24 ppb, and various resin acids/guaiacols up to 230 ppb. Except for phenol and chlorophenols, most of these compounds were also identified in the centrifuged effluent solids.

Concentrations of organics in the centrifuged effluent solids ranged from up to 48 ppm dry weight (mg/kg dry weight) for the PAHs, up to 15 ppm for the resin acid/guaiacols, 26 ppm for 4-methylphenol, 1.9 ppm for chloroform, 27 ppm for 2-butanone, and 0.32 ppm for toluene.

Three of the four organics found in the whole effluent were also detected in the centrifuged effluent solids (chloroform, 3,4,5-trichloroguaiacol, and tetrachloroguaiacol). However, many other organics were detected in greater concentrations in the centrifuged solids than these three that were not found in the whole effluent (e.g. PAHs, 4-methylphenol, 2-butanone, and 12-and 14-chlorodehydroabietic acid).

Influent, effluent, and centrifuge effluent metals are listed in Table 6. The distribution for different metals between the effluent and centrifuged effluent solids varied. For instance, copper and nickel were similar in the effluent sample (23.2 and 22.4 ppb, respectively). However, copper was over three times greater than nickel in the centrifuged solids. Cadmium, selenium, silver, and thallium were detected in the centrifuged solids and not in the whole effluent.

Influent and effluent metals are compared to Washington State water quality criteria for protection of aquatic life in Table 7. Copper in the effluent exceeded saltwater acute criteria. Chronic criteria were exceeded for both salt- and freshwater by mercury and for saltwater only by nickel. It should be noted that the effluent was analyzed for total metals which may overestimate actual toxic concentrations. EPA recommends the use of the total recoverable analytical methods for metals when comparing results to water quality criteria.

Sediment Bioassay Results

Sediment bioassay results are listed in Table 8. The outfall and near-outfall sediments showed similar amphipod survival compared to the field control sample. However, all three samples exhibited a slight decrease in survival compared to laboratory control sediments. Sediments at the chlorine plant outfall were acutely toxic to the amphipod, with only 23 percent surviving after the 10-day exposure period.

Sediment Chemistry

Priority pollutant organics detected at the outfall, near-outfall, field control, and chlorine plant outfall sediments are compared to draft Sediment Quality Standards (Ecology, 1989) in Table 9. Table 9 also includes results for the centrifuged effluent solids. Resin acids/guaiacols identified in the samples are listed in Table 10. Complete results are given in Appendix 1.

All priority pollutants organics detected in the outfall, near-outfall and field control sediments were far below draft sediment quality criteria. The near-outfall sediments generally showed the highest levels of contamination. Compounds found included PAHs, a phthalate, and various resin acids/guaiacols. Most compounds detected in the outfall and near-outfall sediments also appeared in the centrifuged effluent solids. Compounds in the effluent solids that were not found in the sediments included 4-methylphenol, naphthalene, acenaphthene, 4,5,6-trichloroguaiacol and tetrachloroguaiacol.

Table 6. Metals Detected in Water Samples - Georgia Pacific, 8/88.

Metal (total)	Influent (ug/L)	Effluent (ug/L)	Centrifuged Effluent Solids (mg/kg dry)
Antimony	1.2	1 U	2 U
Arsenic	3.7	3.7	3.2
Beryllium	1.3	1.2	0.35
Cadmium	10 U	10 U	7.3
Chromium	266	116	112
Copper	29.6	23.2	57.8
Lead	7.9	4.2	29.3
Mercury	1.09	0.39	1.89
Nickel	20 U	22.4	16.1
Selenium	1 U	1 U	1.4
Silver	0.5 U	0.5 U	0.37
Thallium	1 U	1 U	0.19
Zinc	205 B	201 B	585

Qualifiers:
U - Not detected at detection limit shown.
B - Also detected in method blank.

Table 7. Metal Results Compared to Water Quality Criteria - Georgia Pacific, 8/88.

Metal (total)	Influent (ug/L)	Effluent (ug/L)	Water Quality Criteria* Freshwater Acute (ug/L)	Freshwater Chronic (ug/L)	Saltwater Acute (ug/L)	Saltwater Chronic (ug/L)
Antimony	1.2	1 U	9,000	1,600	--	--
Arsenic	3.7	3.7	360	190	69	36
Beryllium	1.3	1.2	130	5.3	--	--
Chromium	266	116	7,942	947	--	--
Copper	29.6	23.2	101.9	57.8	2.9	--
Lead	7.9	4.2	867.4	33.8	140	5.6
Mercury	1.09	0.39	2.40	0.012	2.10	0.025
Nickel	20 U	22.4	6,820	758	75	8.3
Zinc	205 B	201 B	564	511	95	86
Hardness		640				

Qualifiers:
U - Not detected at detection limit shown.
B - Also detected in method blank.
* - Criteria based on total recoverable method.

Table 8. Sediment Bioassay Results - Georgia Pacific, 8/88.

Station	Percent Solids	Percent TOC	Grain Size Analysis			Sediment Amphipody Percent Survival
			Percent Gravel	Percent Sand	Percent Fines*	
Field Control	26.9	2.4	<2.0	1.3	98.7	92.5 +/- 0.02
At Outfall	41.3	2.2	<2.0	19.4	80.6	88.0 +/- 0.05
Near Outfall	35.0	3.3	<2.0	3.9	96.2	94.0 +/- 0.04
Chlorine Plant Outfall	26.3	8.3	<2.0	23.5	76.6	23.0 +/- 0.10
Laboratory Control	--	--	--	--	--	99.0 +/- 0.02

* - Silt + Clay (62um - <4um).

Table 9. Organics in Sediments Compared to Sediment Quality Criteria - Georgia Pacific, 8/88.

Compound	Centrifuged Effluent Solids (ug/kg dry)	Sediments (μg/kg dry)+ Field Control	At Outfall	Near Outfall	Chlorine Plant Outfall	Draft Sediment Quality Standards (mg/Kg organic Carbon)
% Fines*	96.2	98.7	80.6	96.2	76.6	
% Sand	3.8	1.3	19.4	3.9	23.5	
% Gravel	<2.0	<2.0	<2.0	<2.0	<2.0	
% TOC	37.0	2.4	2.2	3.3	8.3	
% Dry Weight	15.1	26.9	41.3	35.0	26.3	
Volatile Organics:						
Chloroform	1,900	7.0 U	5.0 U	5.0 U	7.0 U	--
2-Butanone	27,000	22.0 U	15.0 U	15.0 U	32.0	--
Toluene	320	7.0 U	5.0 U	5.0 U	9.0	--
Total Xylenes	10.0 U	7.0 U	5.0 U	5.0 U	11.0	--
Phenols:						
4-Methylphenol	26,000 (70)E	250 U	160 U	190 U	250 U	420 **
Low Molecular Weight PAHs:						
Anthracene	13,000 U	250 U	160 U	190 U	890 (11)E	220
aphthalene	32,000 (87)E	500 U	320 U	380 U	510 U	99
Acenaphthylene	16,000 (43)E	250 U	160 U	190 U	250 U	66
Acenaphthene	13,000 U	250 U	160 U	190 U	760 (9)E	66
Fluorene	13,000 U	250 U	160 U	190 U	460 (6)E	23
Phenanthrene	48,000 (130)E	250 U	310 (14)E	500 (15)E	4,200 (51)E	100
Total LMW PAHs	96,000 (260)E	--	310 (14)E	500 (15)E	6,310 (76)E	370
High Molecular Weight PAHs:						
Pyrene	37,000 (100)E	250 U	370 (17)E	610 (19)E	9,900 (120)E	1,000
Fluoranthene	40,000 (110)E	250 U	270 (12)E	420 (13)E	7,000 (84)E	160
Benzo(a)Anthracene	13,000 U	250 U	160 U	190 U	5,200 (63)E	110
Chrysene	13,000 U	250 U	160 U	190 U	6,300 (76)E	110
Benzo(b)Fluoranthene	26,000 U	500 U	320 U	380 U		--
Benzo(k)Fluoranthene	26,000 U	500 U	320 U	380 U	13,000 (160)E	--
Benzo(a)Pyrene	26,000 U	500 U	320 U	380 U	6,600 (80)E	99
Indeno(1,2,3-cd)Pyrene	26,000 U	500 U	320 U	380 U	3,200 (39)E	33
Dibenzo(a,h)Anthracene	26,000 U	500 U	320 U	380 U	1,300 (16)E	33
Benzo(ghi)Perylene	26,000 U	500 U	320 U	380 U	3,100 (37)E	31
Total HMW PAHs	77,000 (210)E	--	640 (29)E	1,030 (31)E	54,600 (660)E	960
Phthalates:						
bis(2-Ethylhexyl)Phthalate	13,000 B	590 (25)E	270 (12)E	290 (9)E	1,200 (15)E	47
Miscellaneous:						
Dibenzofuran	13,000 U	250 U	160 U	190 U	300 (3.6)E	15

U - Not detected at detection limit shown.
J - Estimated amount, concentration is below method detection limit.
E - Estimated amount, EPA CLP holding time from extraction to analyses was exceeded.
+ - Value in parenthesis is concentration in mg/kg organic carbon.
* - Silt + Clay (62um - <4um).
** - Value in ug/kg dry weight (ppb dry).

Table 10 - Resin Acids/Guaiacols Detected in Sediment Samples - Georgia Pacific, 8/88.

	Centrifuged Effluent Solids (ug/kg dry)		Sediments - ug/kg dry weight					
			Field Control		At Outfall		Near Outfall	
% Fines*	96.2		98.7		80.6		96.2	
% Sand	3.8		1.3		19.4		3.9	
% Gravel	<2.0		<2.0		<2.0		<2.0	
% TOC	37.0		2.4		2.2		3.3	
% Dry Weight	15.1		26.9		41.3		35.0	
Isopimeric Acid	960	U	110	U	70	U	110	
Palustric Acid	960	J	110	J	70	J	88	J
Abietic Acid	1,600		110	U	83		260	
Dehydroabietic Acid	2,500		110		190		300	
14-Chlorodehydroabietic Acid	3,000		110	U	90		190	
12-Chlorodehydroabietic Acid	15,000		110		520		1,100	
Dichlorodehydroabietic Acid	13,000		110	U	330		660	
Guaiacol	1,400		36		23		29	
3,4,5-Trichloroguaiacol	3,400		36		23		29	
4,5,6-Trichloroguaiacol	1,400		36	U	23	U	29	U
Tetrachloroguaiacol	5,100		36	U	23	U	29	U

U - Not detected at detection limit shown.
J - Estimated amount, concentration is below method detection limit.
* - Silt + Clay (62um-<4um).

Metal results for the sediment samples are compared to draft sediment quality standards in Table 11. Mercury in the outfall and near-outfall sediments (at 0.48 and 0.77 ppm dry weight, respectively) exceeded the draft sediment quality standard (0.41 ppm dry). All other metals were below the draft criteria. Arsenic, cadmium, chromium, copper, lead, nickel, and zinc appeared to be elevated in the outfall sediments compared to the field control sediments. All these metals were also detected in the centrifuged effluent solids at concentrations ranging from 1.89 ppm dry for mercury to 585 ppm dry for zinc.

Sediments at the chlorine plant outfall were contaminated with numerous PAHs (54,600 ppb dry of high molecular weight PAHs and 6,310 ppb dry of low molecular weight PAHs), mercury (34.9 ppm dry), dibenzofuran (300 ppb dry), 2-butanone (32 ppb dry), toluene (9 ppb dry) and total xylenes (11 ppb dry). Concentrations of two of the PAHs (benzo[g,h,i]perylene and indeno[1,2,3-cd]pyrene) slightly exceeded draft sediment quality standards. Mercury exceeded the draft standard by almost two orders of magnitude.

Mercury concentrations found in the immediate area of the chlor-alkali plant during this inspection are consistent with past sampling. Mercury levels of up to 100 ppm dry weight were found during a 1970-72 sampling (Crecelius *et al.*, 1975). In addition, concentrations of 27 to 37 ppm dry weight near the chlor-alkali plant outfall were documented in a 1979-1980 survey (Ecology, 1980).

Currently, the Sediment Management Unit within Ecology's Central Programs is developing a sediment cleanup decision process for the cleanup of contaminated marine sediments. Chemical and biological criteria are used to evaluate marine sediments. When biological criteria are applied, they override any indications based on chemical testing (Ecology, 1989). The biological criteria are met when the sediment passes two acute, and one of three chronic bioassays. Biological criteria are not met when any one of two acute, and one of three chronic sediment bioassays fails.

Sediments at the chloro-alkali plant failed both the chemical (for mercury and two PAHs) and biological criteria (amphipod bioassay). The extent of this contamination should be made so that appropriate cleanup measures can take place in the future. Sediments at and near the outfall exceeded the chemical criteria for mercury. However, no statement can be made concerning the biological criteria; only one acute bioassay was performed out of the required two, and no chronic test was performed.

Comparison of Laboratory Results

A comparison of laboratory results from the Ecology and mill labs is given in Table 12. Influent BOD measured by Georgia Pacific was about 13 percent higher than results obtained by Ecology. However, effluent BOD between the two labs compared very well. Ecology's results for effluent TSS were about 30 percent higher than the Georgia Pacific results. Mercury results from the two labs compare fairly well.

LABORATORY REVIEW

Lab procedures for BOD and TSS at the mill were acceptable. A complete laboratory review sheet is included in Appendix 2 of this report.

Table 11. Sediment Metals Compared to Sediment Quality Criteria - Georgia Pacific, 8/88.

Metal	Centrifuged Effluent Solids (mg/kg dry)	Sediments (mg/kg dry)				Sediment Quality Standard (mg/kg dry)
		Field Control	At Outfall	Near Outfall	Chlorine Plant Outfall	
% Fines*	96.2	98.7	80.6	96.2	76.6	
% Sand	3.8	1.3	19.4	3.9	23.5	
% Gravel	<2.0	<2.0	<2.0	<2.0	<2.0	
% TOC	37.0	2.4	2.2	3.3	8.3	
% Dry Weight	15.1	26.9	41.3	35.0	26.3	
Arsenic	3.2	7.0	9.2	11.8	6.9	57
Beryllium	0.35	0.48	0.41	0.53	0.53	--
Cadmium	7.3	0.2 U	0.2 U	0.53	1.24	5.1
Chromium	112	64.7	71.0	85.8	66.2	260
Copper	57.8	41.1	50.0	52.9	68.9	390
Lead	29.3	18.2	35.3	17.6	40.9	450
Mercury	1.89	0.26	0.48	0.77	34.9	0.41
Nickel	16.1	56.3	80.0	106	66.1	--
Selenium	1.4	0.63	0.35	0.45	0.44	--
Silver	0.37	0.16	0.14	0.16	0.29	6.1
Thallium	0.19	0.13	0.17	0.17	0.43	--
Zinc	585	109	122	120	167	410

U - Not detected at detection limit shown.

Table 12. Comparison of Laboratory Results - Georgia Pacific, 8/88.

Sample:	Influent			Effluent				Mercury Recovery Unit Effluent	
Type:	Composite			Composite				Grab	
Date:	9/20-21			9/20-21				9/20	
Time:	2400-2400			2400-2400				1543	
Sampler:	Ecology		Geo-Pac	Ecology		Geo-Pac		Ecology	Geo-Pac
Laboratory:	Ecology	Geo-Pac	Geo-Pac	Ecology	Geo-Pac	Ecology	Geo-Pac	Ecology	Geo-Pac
BOD_5 (mg/L)	390	445	455	20	18	15	18		
TSS (mg/L)	190	180	178	80	54	76	53		
Mercury (ug/L)								4.8; 5.7	4.8

CONCLUSIONS AND RECOMMENDATIONS

1. The mill met all NPDES permit limitations during the inspection. However, total mercury in the influent, effluent, and clear water samples was detected above the permit requirement for the mercury recovery unit effluent. The source of the mercury in the clear water and influent wastewater streams should be identified. Permit limits for total mercury should be included in the next NPDES permit for the influent, effluent, and clear water wastewater streams.

2. Whole effluent toxic pollutant analyses found only trace quantities of organic contamination. However, influent and centrifuged effluent solids identified various PAHs, resin acids/guaiacols, phenols, and other organics. Sediments surrounding the wastewater diffuser section were mildly contaminated with many of the organics detected in the centrifuged effluent solids. All organic concentrations were below draft sediment chemical criteria. However, mercury at and near the outfall exceed the proposed chemical criteria.

3. Effluent bioassay results indicate the effluent was not acutely toxic to rainbow trout, fathead minnow or *Daphnia pulex*. The effluent also showed no mutagenic response in the Ames test. However, significant chronic effects were observed in the Echinoderm sperm fertilization bioassay. This bioassay, along with the pacific oyster embryo development bioassay, should be used as the chronic bioassay requirement in the next NPDES permit.

   Sediments collected around the main outfall diffuser showed no significantly different survival in the sediment amphipod bioassay compared to field control sediments.

4. Sediments at the chlor-alkali plant outfall were contaminated with mercury and PAHs. Mercury and two PAH concentrations exceeded draft sediment chemical criteria. These sediments also failed the draft sediment biological criteria by exhibiting a high amphipod bioassay mortality. The current extent of the contamination surrounding this outfall should be made so that appropriate cleanup measures can take place in the future.

5. Lab procedures at the mill were acceptable.

REFERENCES

Crecelius, E.A., M.H. Bothner, and R. Carpenter, 1975. "Geochemistries of Arsenic, Antimony, Mercury, and Related Elements in Sediments of Puget Sound," Environmental Science and Technology, Vol. 9, Number 4, April 1975. pp 325-333.

Ecology, 1980. Water Quality Conditions in the Bellingham Bay Area, 1979-1980. Department of Ecology Report 50-14, December 1980.

Ecology, 1989. Draft Interim Sediment Quality Evaluation Process for Puget Sound, Washington State Department of Ecology, October 1989.

EPA, 1980. Ambient Water Quality Criteria for Hexachlorocyclohexane, EPA 440/5-80-054, October 1980.

Kjosness, D., 1988. Ecology Memorandum to Dick Burkhalter, April 21, 1988.

Kjosness, D., Personal Communication. Ecology Industrial Section.

Tetra Tech, 1986. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Final Report No. TC-3991-04, March 1986.

APPENDIX 1

Chemical Analytical Methods - Georgia Pacific, 8/88.

Analyses	Method Used	Laboratory
TOC (water)	EPA, 1983: #415	Ecology; Manchester, WA
TOC (solids)	APHA, 1985: #505	Laucks Testing Labs; Seattle, WA
TOX (water)	EPA, 1986: #9020	Ecology; Manchester, WA
% Solids	APHA, 1985: #209F	Laucks Testing Labs; Seattle, WA
Grain Size	Tetra Tech, 1986	Laucks Testing Labs; Seattle, WA
Cyanide (water)	EPA, 1983: #335.2-1	Ecology; Manchester, WA
Total Phenolics	EPA, 1983: #420.2	Ecology; Manchester, WA
Volatiles (water)	EPA, 1984: #624	Laucks Testing Labs; Seattle, WA
Volatiles (solids)	EPA, 1986: #8240	Laucks Testing Labs; Seattle, WA
Semivolatiles (water)	EPA, 1984: #625	Laucks Testing Labs; Seattle, WA
Semivolatiles (solids)	EPA, 1986: #8270	Laucks Testing Labs; Seattle, WA
Pest/PCB (water)	EPA, 1984: #608	Laucks Testing Labs; Seattle, WA
Pest/PCB (solids)	EPA, 1986: #8080	Laucks Testing Labs; Seattle, WA
Metals (water)	EPA, 1983: #200 series	Ecology; Manchester, WA
Metals (solids)	EPA, 1983: #200 series	Ecology; Manchester, WA
Resin acids/guaiacols (water + solids)	NCASI, 1986	Laucks Testing Labs; Seattle, WA
Ammonia	EPA, 1983: #350.1	Ecology; Manchester, WA
Total Phosphorus	EPA, 1983: #353.2	Ecology; Manchester, WA
Nitrate/Nitrite	EPA, 1983: #365.1	Ecology; Manchester, WA

APHA-AWWA-WPCF, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed.

EPA, 1983. Methods for Chemical Analysis of Water and Wastes, 600/4/79-020, revised March 1983.

EPA, 1984. 40 CFR Part 136, October 26, 1984.

EPA, 1986. Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, 3rd ed., November 1986.

National Council for Air and Stream Improvement, 1986. Procedures for the Analysis for Resin and Fatty Acids in Pulp Mill Effluents. Tech. Bull. 501. New York, N.Y.

Tetra Tech, 1986, Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Prepared for Puget Sound Estuary Program.

Effluent and Sediment Bioassay Methods - Georgia Pacific, 8/88.

Test Organism	Test Sample	Reference Method	Test Laboratory	Test Duration	Test Concentration	Type of Test	Endpoint Measured
Rhepoxynius abronius	Sediment	1	Ecology	10 days	N/A	Acute and Chronic	Survival and avoidance
Daphnia pulex	Effluent	2	Ecology	48 hrs	100%	Acute	Survival
Rainbow Trout (*Oncorhynchus Mykiss*)	Effluent	3	Ecology	96 hrs	65%	Acute	Survival
Sand Dollar (*Dendraster excentricus*)	Effluent	4	Ecology	20 mins	0.8;1.6;3.1; 6.3;12.5;25;50%	Chronic	% Fertilization
Fathead Minnow (*Pimephales promelas*)	Effluent	2	EA Engineering, Science, and Technology Lafayette, CA	48 hrs	1;10;25;50; 100%	Acute	Survival
Ames Test	Effluent	5	SRI International Menlo Park, CA	48 hrs	50;100;200; 300;400;500 uL per plate	Mutagenic Activity	Genetic damage to *Salmonella typhimurium* bacteria strains TA1535, TA1537, TA1538, TA98, & TA100 with and without metabolic activation

[1] Swartz *et al* (1985) as amended by Chapman and Becker (1986)

[2] EPA/600/4-85/013, "Methods for Measuring the Acute Toxicity of Effluents of Freshwater and Marine Organisms."

[3] Department of Ecology procedure "Static Acute Fish Toxicity Test."

[4] Dinnel, P.A., J.M. Link, and Q.J. Stober, 1987. "Improved Methodology for a Sea Urchin Sperm Cell Bioassay for Marine Waters." Arch. Environ. Contam. Toxicol., 16, 23-32, 1987.

[5] Maron, D.M. and B.N. Ames, 1983. "Revised Methods for the Salmonella Mutagenicity Test," Mutat. Res., 113, 173-215, 1983.

Results of Volatile Priority Pollutant Scan - Georgia-Pacific, 8/88.

Compound	Influent (ug/L)	Effluent (ug/L)	Field Blank (ug/L)	Centrifuged Effluent (ug/kg dry)	Sediments (ug/kg dry) Field Control	At Outfall	Near Outfall	Chlorine Plant Outfall
Chloromethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Bromomethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Vinyl Chloride	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Chloroethane	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
Methylene Chloride	5 U	1	1	2,200	7.0 U	5.0 U	5.0 U	7.0 U
Acetone	25 U	5 U	5 U	45,000	120.0	120.0	71.0	37.0 U
Carbon Disulfide	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
1,1-Dichloroethene	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
1,1-Dichloroethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
1,2-Dichloroethene (total)	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Chloroform	890	42	1 U	1,900	7.0 U	5.0 U	5.0 U	7.0 U
2-Butanone	15 U	3 U	3 U	27,000	22.0 U	15.0 U	15.0 U	32.0
1,2-Dichloroethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
1,1,1-Trichloroethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Carbon Tetrachloride	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Vinyl Acetate	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Bromodichloromethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
1,2-Dichloropropane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Trichloroethene	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Benzene	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Dibromochloromethane	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
1,1,2-Trichloroethane	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Bromoform	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
4-Methyl-2-Pentanone	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
2-Hexanone	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
1,1,2,2-Tetrachloroethane	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
Tetrachloroethene	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Toluene	5 U	1 U	8	320	7.0 U	5.0 U	5.0 U	9.0
Chlorobenzene	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
Trans-1,3-Dichloropropene	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
Ethylbenzene	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Cis-1,3-Dichloropropene	15 U	3 U	3 U	30.0 U	22.0 U	15.0 U	15.0 U	22.0 U
Styrene	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	7.0 U
Total Xylenes	5 U	1 U	1 U	10.0 U	7.0 U	5.0 U	5.0 U	11.0

Qualifiers:
U - Not detected at the detection limit shown.

Results of Semi-Volatile Priority Pollutant Scan - Georgia Pacific, 8/88.

Compound	Influent (ug/L)	Effluent (ug/L)	Field Blank (ug/L)	Centrifuged Effluent (ug/kg dry)	Sediments (ug/kg dry) Field Control	At Outfall	Near Outfall	Chlorine Plant Outfall
Phenol	4	2 U	4	13000 U	250 U	160 U	190 U	250 U
Aniline	10 U	10 U	10 U	66000 U	1250 U	800 U	950 U	1300 U
bis(2-Chloroethyl)Ether	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
2-Chlorophenol	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
1,3-Dichlorobenzene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
1,4-Dichlorobenzene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Benzyl Alcohol	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
1,2-Dichlorobenzene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
2-Methylphenol	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
bis(2-chloroisopropyl)ether	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
4-Methylphenol	2	2 U	2 U	26000	250 U	160 U	190 U	250 U
N-Nitroso-Di-n-Propylamine	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Hexachloroethane	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
Nitrobenzene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Isophorone	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
2-Nitrophenol	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
2,4-Dimethylphenol	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Benzoic Acid	50 U	50 U	50 U	330000 U	6200 U	4900 U	4800 U	6300 U
bis(2-Chloroethoxy)Methane	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
2,4-Dichlorophenol	4	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
1,2,4-Trichlorobenzene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Naphthalene	24	4 U	4 U	32000	500 U	320 U	380 U	510 U
4-Chloroaniline	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Hexachlorobutadiene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
4-Chloro-3-Methylphenol	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
2-Methylnaphthalene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Hexachlorocyclopentadiene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
2,4,6-Trichlorophenol	23	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
2,4,5-Trichlorophenol	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
2-Chloronaphthalene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
2-Nitroaniline	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
Dimethyl Phthalate	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Acenaphthylene	11	2 U	2 U	16000	250 U	160 U	190 U	250 U
3-Nitroaniline	10 U	10 U	10 U	66000 U	1200 U	810 U	950 U	1300 U
Acenaphthene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	760
2,4-Dinitrophenol	20 U	20 U	20 U	130000 U	2500 U	1600 U	1900 U	2500 U
4-Nitrophenol	20 U	20 U	20 U	130000 U	2500 U	1600 U	1900 U	2500 U
Dibenzofuran	4	2 U	2 U	13000 U	250 U	160 U	190 U	300
2,4-Dinitrotoluene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
2,6-Dinitrotoluene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
Diethylphthalate	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
4-Chlorophenyl-phenylether	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Fluorene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	460
4-Nitroaniline	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
4,6-Dinitro-2-Methylphenol	20 U	20 U	20 U	130000 U	2500 U	1600 U	1900 U	2500 U
N-Nitrosodiphenylamine	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
1,2-Diphenylhydrazine	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
4-Bromophenyl-phenylether	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
Hexachlorobenzene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	510 U
Pentachlorophenol	20 U	20 U	20 U	130000 U	2500 U	1600 U	1900 U	2500 U
Phenanthrene	11	2 U	2 U	48000	250 U	310	500	4200
Anthracene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	890
Di-n-Butylphthalate	2 U	2 U	2 U	13000 U	250 U	160 U	380 U	250 U
Fluoranthene	5	2 U	2 U	40000	250 U	270	420	7000
Pyrene	5	2 U	2 U	37000	250 U	370	610	9900
Benzidine	50 U	50 U	50 U	330000 U	6200 U	4000 U	4800 U	6300 U
Butylbenxylphthalate	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
3,3'-Dichlorobenzidine	20 U	20 U	20 U	130000 U	2500 U	1600 U	1900 U	2500 U
Benzo(a)Anthracene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	5200
bis(2-Ethylhexyl)Phthalate	2 U	2 U	2 U	13000 B	590	270	290	1200
Chrysene	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	6300
Di-n-Octyl Phthalate	2 U	2 U	2 U	13000 U	250 U	160 U	190 U	250 U
Benzo(b)Fluoranthene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	13000 S
Benzo(k)Fluoranthene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	13000 S
Benzo(a)Pyrene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	6600
Indeno(1,2,3-cd)Pyrene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	3200
Dibenzo(a,h)Anthracene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	1300
Benzo(ghi)Perylene	4 U	4 U	4 U	26000 U	500 U	320 U	380 U	3100

Qualifiers:
U - Not detected at detection limit shown.
S - The sum of benzo(b) and benzo(k) fluroanthene.

Results of Priority Pollutant Metals - Georgia Pacific, 8/88.

Metal (total)	Influent (ug/L)	Effluent (ug/L)	Centrifuged Effluent (mg/kg dry)	Field Blank (ug/L)	Sediments (mg/kg dry)			
					Field Control	At Oufall	Near Outfall	Chlorine Plant Outfall
Antimony	1.2	1 U	2 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Arsenic	3.7	3.7	3.2	1 U	7.0	9.2	11.8	6.9
Beryllium	1.3	1.2	0.35	1 U	0.48	0.41	0.53	0.53
Cadmium	10 U	10 U	7.3	10 U	0.2 U	0.2 U	0.53	1.24
Chromium	266	116	112	10 U	64.7	71.0	85.8	66.2
Copper	29.6	23.2	57.8	2.0 U	41.1	50.0	52.9	68.9
Lead	7.9	4.2	29.3	2 U	18.2	35.3	17.6	40.9
Mercury	1.09	0.39	1.89	0.06 U	0.26	0.48	0.77	34.9
Nickel	20 U	22.4	16.1	20 U	56.3	80.0	106	66.1
Selenium	1 U	1 U	1.4	1 U	0.63	0.35	0.45	0.44
Silver	0.5 U	0.5 U	0.37	0.5 U	0.16	0.14	0.16	0.29
Thallium	1 U	1 U	0.19	1 U	0.13	0.17	0.17	0.43
Zinc	205 B	201 B	585	2 B	109	122	120	167

Qualifiers:
U - Not detected at detection limit shown.
B - Also detected in method blank.

Results of Pesticide Priority Pollutant Scan - Georgia Pacific, 8/88.

Compound	Influent (ug/L)	Effluent (ug/L)	Field Blank (ug/L)	Centrifuged Effluent (ug/kg dry)	Sediments (ug/kg dry) Field Control	At Outfall	Near Outfall	Chlorine Plant Outfall
Apha-BHC	0.30 I	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Beta-BHC	1.60 I	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Delta-BHC	0.20	0.50	0.05 U	8 U	8 U	8 U	8 U	8 U
Gamma-BHC (Lindane)	0.50 I	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Heptachlor	0.05 U	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Aldrin	0.05 U	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Heptachlor Epoxide	0.05 U	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Endosulfan I	0.05 U	0.05 U	0.05 U	8 U	8 U	8 U	8 U	8 U
Dieldrin	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
4,4'-DDE	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
Endrin	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
Endosulfan II	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
4,4'-DDD	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
Endosulfan Sulfate	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
4,4'-DDT	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
Methoxychlor	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Endrin Ketone	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
alpha-Chlordane	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
gamma-Chlordane	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Toxaphene	1.00 U	1.00 U	1.00 U	160 U	160 U	160 U	160 U	160 U
Endrin Aldehyde	0.10 U	0.10 U	0.10 U	16 U	16 U	16 U	16 U	16 U
Aroclor-1016	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Aroclor-1221	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Aroclor-1232	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Aroclor-1242	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Aroclor-1248	0.50 U	0.50 U	0.50 U	80 U	80 U	80 U	80 U	80 U
Aroclor-1254	1.00 U	1.00 U	1.00 U	160 U	160 U	160 U	160 U	160 U
Aroclor-1260	1.00 U	1.00 U	1.00 U	160 U	160 U	160 U	160 U	160 U

Qualifiers:
U - Not detected at detection limit shown.
I - Detection limit higher due to matrix effects.

Results of Resin Acid/Guaiacol Scan - Georgia Pacific, 8/88.

Compound	Influent (ug/L)	Effluent (ug/L)	Field Blank (ug/L)	Centrifuged Effluent (ug/kg dry)	Sediments (ug/kg dry) Field Control	At Outfall	Near Outfall
Sandaracopimeric Acid	3 U	6 U	3 U	960 U	110 U	70 U	88 U
Isopimeric Acid	10	6 U	3 U	960 U	110 U	70 U	110
Palustric Acid	3 U	6 U	3 U	960 J	110 J	70 J	88 J
Abietic Acid	18	6 U	3 U	1600	110 U	83	260
Neoabietic Acid	3 J	6 J	3 J	960 J	110 J	70 J	88 J
Dehydroabietic Acid	93	6 U	3 U	2500	110	190	300
14-Chlorodehydroabietic Acid	120	6 U	3 U	3000	110 U	90	190
12-Chlorodehydroabietic Acid	230	6 U	3 U	15000	110	520	1100
Dichlorodehydroabietic Acid	59	6 U	3 U	13000	110 U	330	660
Guaiacol	94	2 U	1 U	1400	36	23	29
4,5-Dichloroguaiacol	2	2 U	1 U	320 U	36 U	23 U	29 U
3,4,5-Trichloroguaiacol	7	5	1 U	3400	36	23	29
4,5,6-Trichloroguaiacol	4	2 U	1 U	1400	36 U	23 U	29 U
Tetrachloroguaiacol	8	7	1 U	5100	36 U	23 U	29 U

Qualifiers:
U - Not detected at the detection limit shown.
J - Estimated result, value is less than the method detection limit.

APPENDIX 2

Laboratory Procedure Review Sheet

Discharger: Georgia-Pacific

Date: 8/23/88

Discharger representative: Dick Mclead

Ecology reviewer: Carlos E. Ruiz / Don Kjosness

Instructions

Questionnaire for use reviewing laboratory procedures. Circled numbers indicate work is needed in that area to bring procedures into compliance with approved techniques. References are sited to help give guidance for making improvements. References sited include:

Ecology = Department of Ecology Laboratory User's Manual, December 8, 1986.

SM = APHA-AWWA-WPCF, Standard Methods for the Examination of Water and Wastewater, 16th ed., 1985.

SSM = WPCF, Simplified Laboratory Procedures for Wastewater Examination, 3rd ed., 1985.

Sample Collection Review

1. Are grab, hand composite, or automatic composite samples collected for ~~influent~~ and effluent BOD and TSS analysis?

2. If automatic compositor, what type of compositor is used? non comercial
The compositor should have pre and post purge cycles unless it is a flow
no through type. Check if you are unfamiliar with the type being used.
flow through with vacuum to empty line

3. Are composite samples collected based on time or flow?

4. What is the usual day(s) of sample collection? daily

5. What time does sample collection usually begin? 2am - 3am start

6. How long does sample collection last? 24 hrs

7. How often are subsamples that make up the composite collected? 1-1½ hrs.

8. What volume is each subsample? 3 gallons total ∴ 500 ml/hr

9. What is the final volume of sample collected? 3-4 gallon

10. Is the composite cooled during collection? yes

11. To what temperature? ? ≈ 4°C
The sample should be maintained at approximately 4 degrees C (SM p41, #5b: SSM p2).

12. How is the sample cooled? mechanica
Mechanical refrigeration or ice are acceptable. Blue ice or similar products are often inadequate.

13. How often is the temperature measured? 1 month recommend (don't check now)
The temperature should be checked at least monthly to assure adequate cooling.

14. Are the sampling locations representative? yes

15. Are any return lines located upstream of the influent sampling location?
This should be avoided whenever possible.

16. How is the sample mixed prior to withdrawal of a subsample for analysis? shake by hand
The sample should be thoroughly mixed.

17. How is the subsample stored prior to analysis? 4°C
The sample should be refrigerated (4 degrees C) until about 1 hour before analysis, at which time it is allowed to warm to room temperature.

18. What is the cleaning frequency of the collection jugs? rinse
The jugs should be thoroughly rinsed after each sample is complete and occasionally be washed with a non-phospate detergent.

19. How often are the sampler lines cleaned? replace 1 month before
Rinsing lines with a chlorine solution every three months or more often where necessary is suggested.

pH Test Review

1. How is the pH measured? continuos probe
A meter should be used. Use of paper or a colorimetric test is inadequate and those procedures are not listed in Standard Methods (SM p429).

2. How often is the meter calibrated? daily (laboratory) 2 weeks - 1 month continue
The meter should be calibrated every day it is used.

3. What buffers are used for calibration? 7 and 4
Two buffers bracketing the pH of the sample being tested should be used.

If the meter can only be calibrated with one buffer, the buffer closest in pH to the sample should be used. A second buffer, which brackets the pH of the sample should be used as a check. If the meter cannot accurately determine the pH of the second buffer, the meter should be repaired.

BOD Test Review

1. What reference is used for the BOD test? 16th edition
   Standard Methods or the Ecology handout should be used.

2. How often are BODs run? daily
   The minimum frequency is specified in the permit. FSSMT → wed
   Collected but not run for 4 days
3. How long after sample collection is the test begun? wed - T, T - F
   The test should begin within 24 hours of composite sample completion (Ecology Lab Users Manual p42). Starting the test as soon after samples are complete is desirable.

4. Is distilled or deionized water used for preparing dilution water? → RO

5. Is the distilled water made with a copper free still? yes
   Copper stills can leave a copper residual in the water which can be toxic to the test (SSM p36).

6. Are any nitrification inhibitors used in the test? What? no
   2-chloro-6(trichloro methyl) pyridine or Hach Nitrification Inhibitor 2533 may be used only if carbonaceous BODs are being determined (SM p 527, #4g: SSM p 37).

7. Are the 4 nutrient buffers of powder pillows used to make dilution water? yes
   If the nutrients are used, how much buffer per liter of dilution water are added? .3 per bottle
   1 mL per liter should be added (SM p527, #5a: SSM p37).

8. How often is the dilution water prepared? before BOD run aged wat
   Dilution water should be made for each set of BODs run.

9. Is the dilution water aged prior to use? yes (not with buffers)
   Dilution water with nitrification inhibitor can be aged for a week before use (SM p528, #5b).
   Dilution water without inhibitor should not be aged.

10. Have any of the samples been frozen? yes
    If yes, are they seeded? yes
    Samples that have been frozen should be seeded (SSM p38).

11. Is the pH of all samples between 6.5 and 7.5? 6.5
    If no, is the sample pH adjusted?
    The sample pH should be adjusted to between 6.5 and 7.5 with 1N NaOH or 1N H_2SO_4 if 6.5 > pH >7.5 if caustic alkalinity or acidity is present (SM p529, #5e1: SSM p37).
    High pH from lagoons is usually not caustic. Place the sample in the dark to warm up, then check the pH to see if adjustment is necessary.

    If the sample pH is adjusted, is the sample seeded?
    The sample should be seeded to assure adequate microbial activity if the pH is adjusted (SM p528, #5d).

12. Have any of the samples been chlorinated or ozonated? NO
If chlorinated are they checked for chlorine residual and dechlorinated as necessary?
How are they dechlorinated?
Samples should be dechlorinated with sodium sulfite (SM p529, #5e2: SSM p38), but dechlorination with sodium thiosulfate is common practice. Sodium thiosufate dechlorination is probably acceptable if the chlorine residual is < 1-2 mg/L.
If chlorinated or ozonated, is the sample seeded?
The sample should be seeded if it was disinfected (SM p528, #5d&5e2: SSM p38).

13. Do any samples have a toxic effect on the BOD test? NO
Specific modifications are probably necessary (SM p528, #5d: SSM p37).

14. How are DO concentrations measured? Probe
If with a meter, how is the meter calibrated? water @ 20°C
Air calibration is adequate. Use of a barometer to determine saturation is desirable, although not manditory. Checks using the Winkler method of samples found to have a low DO are desirable to assure that the meter is accurate over the range of measurements being made.

How frequently is the meter calibrated? daily
The meter should be calibrated before use.

15. Is a dilution water blank run? yes
A dilution water blank should always be run for quality assurance (SM p527, #5b: SSM p40, #3).

What is the usual initial DO of the blank? Saturation
The DO should be near saturation; 7.8 mg/L @ 4000 ft, 9.0 mg/L @ sea level (SM p528, #5b). The distilled or deionized water used to make the dilution water may be aged in the dark at ~20 degrees C for a week with a cotton plug in the opening prior to use if low DO or excess blank depletion is a problem .

What is the usual 5 day blank depletion? Less than .2
The depletion should be 0.2 mg/L or less. If the depletion is greater, the cause should be found (SM p527-8, #5b: SSM p41, #6).

16. How many dilutions are made for each sample? 2
At least two dilutions are recommended. The dilutions should be far enough apart to provide a good extended range (SM p530, #5f: SSM p41).

17. Are dilutions made by the liter method or in the bottle?
Either method is acceptable (SM p530, #5f).

18. How many bottles are made at each dilution? 1
How many bottles are incubated at each dilution? 1
When determining the DO using a meter only one bottle is necessary. The DO is measured, then the bottle is sealed and incubated (SM p530, #5f2).
When determining the DO using the Winkler method two bottles are necessary. The initial DO is found of one bottle and the other bottle is sealed and incubated (Ibid.).

19. Is the initial DO of each dilution measured? yes
What is the typical initial DO? near saturation 8.8-8.9 vs 9.1
The initial DO of each dilution should be measured. It should approximate saturation (see #14).

20. What is considered the minimum acceptable DO depletion after 5 days? 2
What is the minimum DO that should be remaining after 5 days? 1
The depletion should be at least 2.0 mg/L and at least 1.0 mg/L should be left after 5 days (SM p531, #6: SSM p41).

21. Are any samples seeded? yes
Which? All
What is the seed source? First stage effluent
Primary effluent or settled raw wastewater is the preferred seed. Secondary treated sources can be used for inhibited tests (SM p528, #5d: SSM p41).

How much seed is added to each sample? 2 ml
Adequate seed should be used to cause a BOD uptake of 0.6 to 1.0 mg/L due to seed in the sample (SM p529, #5d).

How is the BOD of the seed determined? yes
Dilutions should be set up to allow the BOD of the seed to be determined just as the BOD of a sample is determined. This is called the seed control (SM p529, #5d: SSM p41).

22. What is the incubator temperature? 20°C
The incubator should be kept at 20 +/- 1 degree C (SM p531, #5i: SSM p40, #3).

How is incubator temperature monitored? check
A thermometer in a water bath should be kept in the incubator on the same shelf as the BODs are incubated.

How frequently is the temperature checked? daily 2/week
The temperature should be checked daily during the test. A temperature log on the incubator door is recommended.

How often must the incubator temperature be adjusted? 1/6 month
Adjustment should be infrequent. If frequent adjustments (every 2 weeks or more often) are required the incubator should be repaired.

Is the incubator dark during the test period? yes
Assure the switch that turns off the interior light is functioning.

23. Are water seals maintained on the bottles during incubation? yes
Water seals should be maintained to prevent leakage of air during the incubation period (SM p531, #5i: SSM p40, #4).

24. Is the method of calculation correct? Yes
Check to assure that no correction is made for any DO depletion in the blank and that the seed correction is made using seed control data.

Standard Method calculations are (SM p531, #6):

for unseeded samples;

$$BOD\ (mg/L) = \frac{D1 - D2}{P}$$

for seeded samples;

$$BOD\ (mg/L) = \frac{(D1 - D2) - (B1 - B2)f}{P}$$

Where: D1 = DO of the diluted sample before incubation (mg/L)
D2 = DO of diluted sample after incubation period (mg/L)
P = decimal volumetric fraction of sample used
B1 = DO of seed control before incubation (mg/L)
B2 = DO of seed control after incubation (mg/L)

$$f = \frac{\text{amount of seed in bottle D1 (mL)}}{\text{amount of seed in bottle B1 (mL)}}$$

Total Suspended Solids Test Review

Preparation

1. What reference is used for the TSS test? yes

2. What type of filter paper is used?
   Std. Mthds. approved papers are: Whatman 934AH (Reeve Angel), Gelman A/E, and Millipore AP-40 (SM p95,footnote: SSM p23) whatman GFC equivalent?

3. What is the drying oven temperature? 105
   The temperature should be 103-105 degrees C (SM p96, #3a: SSM p23).

4. Are any volatile suspended solids tests run? NO
   If yes--What is the muffle furnance temperature?
   The temperature should be 550+/- 50 degrees C (SM p98, #3: SSM p23).

5. What type of filtering apparatus is used?
   Gooch crucibles or a membrane filter apparatus should be used (SM p95, #2b: SSM p23).

6. How are the filters pre-washed prior to use? yes
   The filters should be rinsed 3 times with distilled water (SM p23, #2: SSM p23, #2).

   Are the rough or smooth sides of the filters up? rough up
   The rough side should be up (SM p96, #3a: SSM p23, #1)

   How long are the filters dried? 1-2
   The filters should be dried for at least one hour in the oven. An additional 20 minutes of drying in the furnance is required if volatile solids are to be tested (Ibid).

   How are the filters stored prior to use? dessicator
   The filters should be stored in a dessicator (Ibid).

7. How is the effectiveness of the dessicant checked? color
   All or a portion of the dessicant should have an indicator to assure effectiveness.

Test Procedure

8. In what is the test volume of sample measured?
   The sample should be measured with a wide tipped pipette or a graduated cylinder.

9. Is the filter seated with distilled water?
   The filter should be seated with distilled water prior to the test to avoid leakage along the filter sides (SM p97, #3c).

10. Is the entire measured volume always filtered? yes
The entire volume should always be filtered to allow the measuring vessel to be properly rinsed (SM p97, #3c: SSM p24, #4).

11. What are the average and minimum volumes filtered?

	Volume	
	Minimum	Average
Influent	100	100
Effluent		

12. How long does it take to filter the samples?

	Time
Influent	30 seconds
Effluent	

13. How long is filtering attempted before deciding that a filter is clogged? never aborted
Prolonged filtering can cause high results due to dissolved solids being caught in the filter (SM p96, #1b). We usually advise a five minute filtering maximum.

14. What do you do when a filter becomes clogged? never NA
The filter should be discarded and a smaller volume of sample should be used with a new filter.

15. How are the filter funnel and measuring device rinsed onto the filter following sample addition? rinse and clean
Rinse 3x's with approximately 10 mLs of distilled water each time (? ?).

16. How long is the sample dried? 1 - 2 hrs
The sample should be dried at least one hour for the TSS test and 20 minutes for the volatile test (SM p97, #3c; p98, #3: SSM p24, #4). Excessive drying times (such as overnight) should be avoided.

17. Is the filter thoroughly cooled in a dessicator prior to weighing?
The filter must be cooled to avoid drafts due to thermal differences when weighing (SM p97, #3c: SSM p97 #3c).

18. How frequently is the drying cycle repeated to assure constant filter weight has ben reached (weight loss <0.5 mg or 4%, whichever is less: SM p97, #3c)?
We recommend that this be done at least once every 2 months.

19. Do calculations appear reasonable? yes
Standard Methods calculation (SM p97, #3c).

$$\text{mg/L TSS} = \frac{(A - B) \times 1000}{\text{sample volume (mL)}}$$

where: A= weight of filter + dried residue (mg)
B= weight of filter (mg)